SOME HALOGEN DERIVATIVES OF P - TOLUIDINE

A Thesis Submitted

To

The Department Of Chemistry

And

The School Of Engineering

Of

The University Of Kansas

In Partial Fulfillment Of

The Requirements For

The Degree Of Bachelor Of Science

In

Chemical Engineering.

By

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June 5,1919.

Approved _____

Preface.

The purpose of this research was to prepare three halogen derivatives of p-toluidine,i. e.,(1) 1 amino-2 chlor-4 methyl benzene,(2) 1 amino-2 brom-4 methyl benzene, (3) 1 amino-2 iodo-4 methyl benzene,and then,by preparing various reaction products of these three compounds,to determine the difference in reactivity of the three halogen derivatives. By this means a general idea of the effect upon reactivity,of substituting the three halogens in a compound may be obtained.

The work may be divided into three divisions,(1) the preparation of the three halogens derivatives,(2) the preparation of the reaction products,and (3) the analysis of the reaction products. However,the work has been presented in only two divisions,the preparation and analysis of the reaction products being placed together.

The author is very much indebted for and wishes to express his appreciation of the many suggestions and valuable aid given by Dr. F. B. Dains,under whose supervision the work was carried out.

Wm. E. Stoudt.

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PREPARATION METHODS

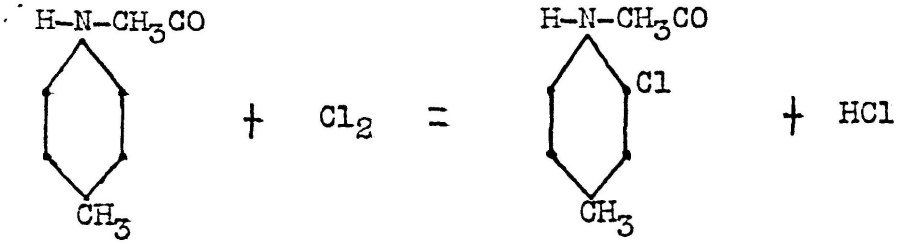
PREPARATION OF 1 AMINO-2 CHLOR-4 METHYL BENZENE.

25 gm. of para-acet-toluide.
Bleaching powder.
100 c.c. of glacial acetic acid.
20 c.c. of hydrochloric acid.
100 c.c. of alcohol.

The 25 gm. of para-acet-toluide were dissolved in an excess of dilute acetic acid and the solution was then heated to 80° C. Bleaching powder that had been rubbed to a cream with water was then added until chlorine was freely given off, the solution being well stirred during the addition. The solution was then set aside until the next day, when the liquid was filtered off from the brownish crystals which had separated.

After being washed and dried the precipitate was boiled with 20 c.c. of hydrochloric acid dissolved in 100 c.c. of alcohol for eight hours, a reflux condenser being used. The alcohol was then distilled off, the solution made alkaline and distilled with steam, when the chlor-para-toluidine came over as a colorless oil. The yiled was 14gm. out of a possible 25 gm. The boiling point, by theory, should be 218-219° C. After the completion of this preparation the para-toluidine used in preparing chlor-para-toluidine was first acetylated and then chlorinated.

The reactions taking place are -



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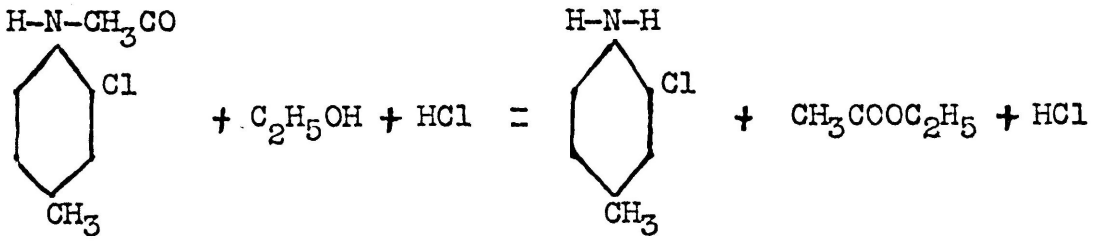


References,

Jour. Am. Chem. Soc. Vol. 69,page 849.

Der Deutsche Chemischen Gesellschaft Vol. 32,page 218

" " " " Vol. 33,page 2500

Beilstein II 481, II* 263.

PREPARATION OF 1 AMINO-2 BROM-4 METHYL BENZENE.

125 gm. p-toluidine.
500 c.c. glacial acetic acid.
20 c.c. acetic anhydride.
* 100 gm. bromine.
* 400 c.c. of alcohol.
* 80 c.c. concentrated HCl.

125 gm. of para-toluidine were dissolved in 200 c.c. of glacial acetic acid and 20 c.c. of acetic anhydride added,and the solution was then boiled under a reflux condenser for about eight hours,or until only a solid product was produced when some of the solution was poured into water. The entire amount was then poured into a beaker of water,and the solution filtered by suction. The crystals were then washed and dried.

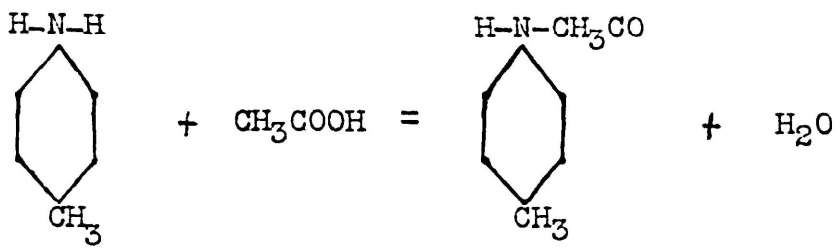
Ninety grams of the para-acet-toluide were then

*only enough for 90gm. of p-acet-toluidine.

taken and dissolved in 600 c.c. of 50% acetic acid,and the solution was then cooled and 100 grams of bromine were added slowly in small quantities,the solution being well stirred. After boiling until the bromine color disappeared, the liquid was poured into an excess of water,when the acet-brom-toluidine separated.

The crystals were then removed by filtration,washed, dried,and then boiled with 400 c.c. of alcohol and 80 c.c. of concentrated hydrochloric acid in a flask,using a reflux condenser. After the solution had been boiled for eight hours it was allowed to cool,and the crystals which separated out were dissolved in water and sodium hydroxide added until the solution was alkaline. The brom-para.toluidine separated out as a yellowish oil,heavier than water. The oil should be colorless and have a boiling point of 242° C. The yield was eighty grams. Three different amounts of this derivative were made,but the eighty grams yield was from ninety grams of the 150 gm. of p-acet-toluidine obtained.

The reactions taking place are -



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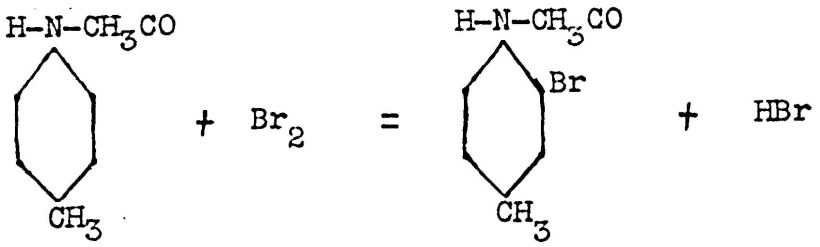

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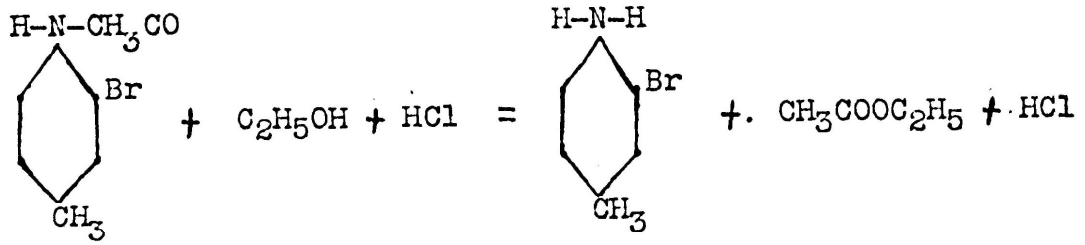

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Liebig's Annalen Vol. 168,page 154.

" " Vol. 173,page 210.

" " Vol. 234,page 156.

Der Deutschen Chemischen Gesellschaft Vol. 15,p.316.

" " " " Vol. 16,p.914.

" " " " Vol. 32,p.219.

Beilstein II 482,II* 263.

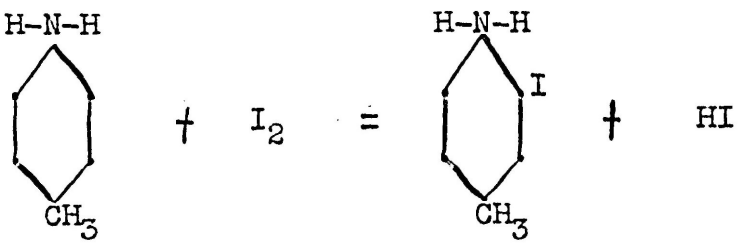
PREPARATION OF 1 AMINO-2 IODO-4 METHYL BENZENE.

25 gm. p-toluidine.
54.4 gm. iodine.
60 c.c. of water.
60 c.c. of ether.
25 gm. calcium carbonate.

Although p-toluidine and iodine will react immediately when mixed in molecular proportions,the reaction will not come to completion. So,after mixing the toluidine and

iodine,the ether,water and alcohol were added,and the mixture was warmed over the steam bath until the iodine color disappeared. The ether was then evaporated and the residue distilled with steam,when the iodo-para-toluidine comes over as a colorless oil and colorless needles. The yield was 33 gm. out of a possible 54 gm. The melting point of the product was by theory 40° C. and was found to be 39° C. Three different amounts of this product were made.

The reaction may be -



References,

American Chemical Journal Vol. 42,page 445.

REACTION PRODUCTS

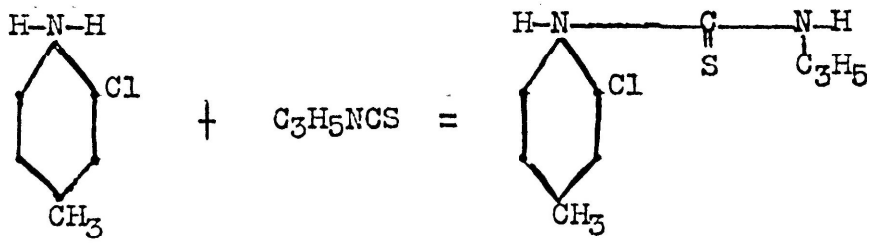
AND

ANALYSES.

2 Cl-4 METHYL-PHENYL-ALLYL-THIO-UREA.

5 gm. chlor-para-toluidine.
3.6 gm. C_3H_5NCS

The chlor-para-toluidine and the mustard oil were mixed in the above mentioned proportions. They reacted almost immediately, giving a solid which was purified by recrystallization from alcohol. The melting point of the colorless crystals was 92° C. The reaction is as follows -



On analysis the following results were obtained -

	I	II
Weight of sample	0.7481gm.	0.5488gm.
c.c. Standard acid used	49.09c.c.	49.16c.c.
c.c. " alkali used	21.14c.c.	27.79c.c.

1 c.c. alkali equals 1.059c.c. of acid.

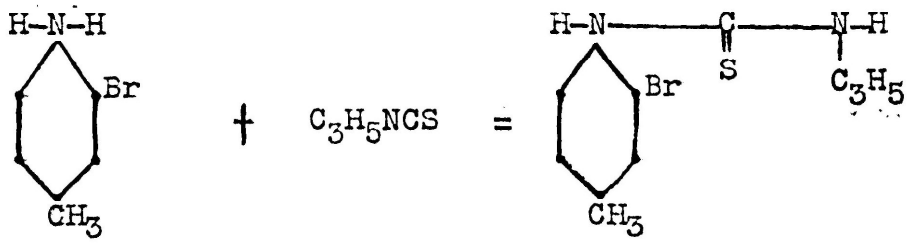
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	Found I	Found II
$\%N_2$	11.67%	11.54%	11.60%

2 BROM-4 METHYL-PHENYL-ALLYL-THIO-UREA.

5 gm. brom-para-toluidine.
2.8 gm. C_3H_5NCS

The brom-para-toluidine and the allyl mustard oil were mixed in a test tube in molecular proportions, and reacted in about 10 minutes, giving a solid product. This solid was purified by recrystallization from alcohol, and was colorless. The melting point was found to be 85° C. The reaction is



The product analysed as follows -

	I	II
Weight of sample	0.6212gm.	0.8520gm.
c.c. Standard acid used	47.86c.c.	48.94c.c.
c.c. " alkali used	27.50c.c.	21.47c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

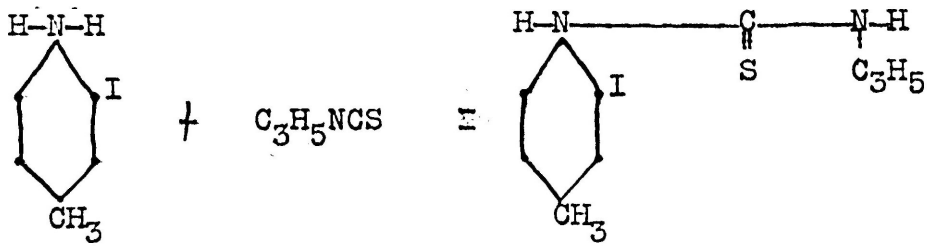
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	Found I	Found II
$\%N_2$	9.82%	9.73%	9.92%

2 IODO-4 METHYL-PHENYL-ALLYL-THIO-UREA.

5 gm. iodo-para-toluidine.
2.2 gm. C_3H_5NCS

The above mentioned quantities of iodo-para-toluidine and allyl mustard oil were mixed in a large test tube, shaken, and allowed to stand. In about an hour the mixture solidified and the solid was purified by repeated crystallization from alcohol. The colorless needles melted at 111° C. The reaction may be represented by



An analysis gave the following results -

	I	II
Weight of sample	0.5121gm.	0.8579gm.
c.c. standard acid used	48.97c.c.	49.01c.c.
c.c. " alkali used	33.77c.c.	25.21c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

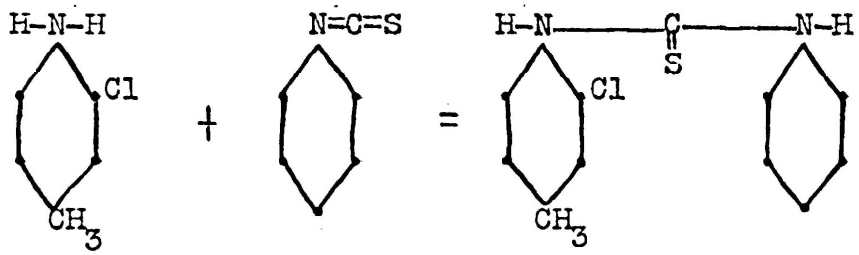
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	8.46%	8.32%		8.39%

2 CHLOR-4 METHYL-PHENYL-PHENYL-THIO-UREA.

5 gm. chlor-para-toluidine.
4.3 gm. C_6H_5NCS.

The chlor-para-toluidine and the phenyl mustard oil were mixed in a large test tube, and on shaking reacted immediately. The solid produced was purified by repeated recrystallization from hot alcohol, and the colorless crystals were found to melt at 156° C. The reaction is



On analysis the following results were obtained -

	I	II
Weight of sample	0.7915gm.	0.5496gm.
c.c. standard acid used	49.31c.c.	49.13c.c.
c.c. " alkali used	23.46c.c.	30.16c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

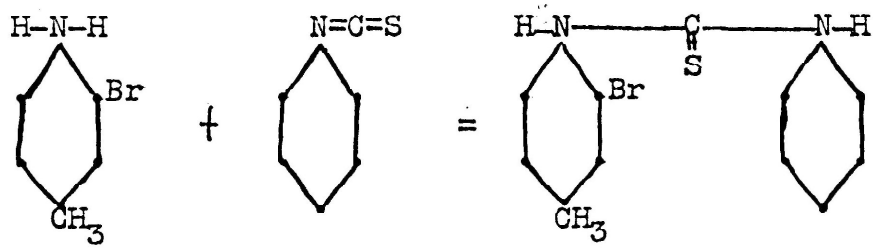
1 c.c. of standard acid equals 0.003226 gm. of N_2

	Calculated	Found I	Found II
$\%N_2$	10.14%	10.02%	10.09%

2 BROM-4 METHYL-PHENYL-PHENYL-THIO-UREA.

5 gm. brom-para-toluidine.
3.5 gm. C_6H_5NCS.

The phenyl mustard oil and the brom-para-toluidine were mixed in the above mentioned proportions in a large test tube, and after standing about fifteen minutes the mixture solidified. The solid product was purified by recrystallization from boiling alcohol. The melting point of the product was 162° C. The reaction is as follows -



The product analysed as follows -

	I	II
Weight of sample	0.7345gm.	1.0221gm.
c.c. standard acid used	49.16c.c.	49.10c.c.
c.c. " alkali used	28.02c.c.	20.56c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

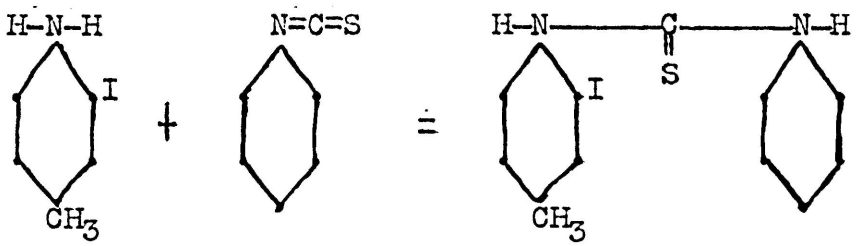
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	8.72%	8.56%		8.63%

2 IODO-4 METHYL-PHENYL-PHENYL-THIO-UREA.

5 gm. iodo-para-toluidine.
2.8 gm. C_6H_5NCS.

The above mentioned portions of iodo-para-toluidine and phenyl mustard oil were mixed and placed in a large test tube. After standing a couple of hours the mixture solidified, and the solid product was purified by recrystallization from boiling alcohol. All of the 2 halogen-4 methyl-phenyl-phenyl-thio-urea's were difficultly soluble in boiling alcohol. The melting point of the fine colorless needles was 160° C. The reaction may be represented by



An analysis gave the following results -

	I	II
Weight of sample	1.8153gm.	0.6216gm.
c.c. of standard acid used	49.01c.c.	49.02c.c.
c.c. standard alkali used	6.66c.c.	32.86c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

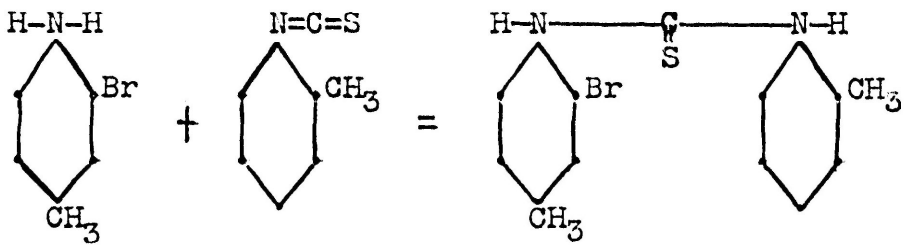
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	7.59%	7.46%		7.38%

2 BROM-4 METHYL-PHENYL-ORTHO-TOLYL-THIO-UREA.

5 gm. brom-para-toluidine.
4 gm. $C_6H_4CH_3NCS$.

The brom-para-toluidine and the ortho-methyl-phenyl mustard oil were mixed in a large test tube and well shaken. After standing for about four hours the mixture solidified, and the solid was then purified by recrystallization from hot alcohol. The colorless crystals melted at 127° C. The reaction is



On analysis the following results were obtained -

	I	II
Weight of sample	0.9766gm.	1.2814gm.
c.c. standard acid used	49.09c.c.	49.22c.c.
c.c. " alkali used	22.76c.c.	15.66c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

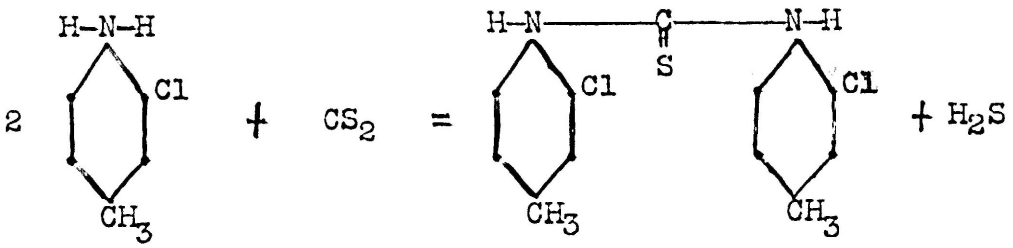
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	8.36%	8.25%		8.22%

DI (2 CHLOR-4 METHYL-PHENYL) THIO-UREA.

5 gm. chlor-para-toluidine.
2.5 gm. carbon disulphide.
0.5 gm. sulphur.

The above mentioned portions of chlor-para-toluidine carbon disulphide and sulphur were mixed,placed in a large test tube and heated on a water bath for about thirty minutes,using a reflux condenser. The solution solidified on standing over night,and the solid product was purified by recrystallization from boiling alcohol. The melting point of the crystals was 134° C. The reaction may be represented by



An analysis gave the following results -

	I	II
Weight of sample	0.4346gm.	0.6727gm.
c.c. standard acid used	49.61c.c.	49.25c.c.
c.c. " alkali used	35.97c.c.	29.65c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

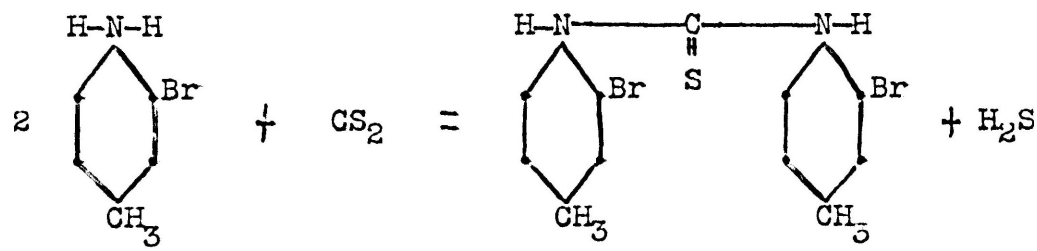
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	8.62%	8.55%		8.56%

DI (2 BROM-4 METHYL-PHENYL) THIO-UREA.

5 gm. brom-para-toluidine.
2 gm. carbon disulphide.
0.5 gm. sulphur.

The brom-para-toluidine, sulphur and carbon disulphide were mixed, placed in a large test tube fitted with a reflux condenser and heated for about an hour on a water bath. After standing a couple of days the solution solidified, and the solid was purified by recrystallization from hot alcohol. The melting point of the crystals was found to be 145° C. The reaction is as follows



The product analysed as follows -

	I	II
Weight of sample	0.3891gm.	0.2415gm.
c.c. standard acid used	48.91c.c.	49.32c.c.
c.c. " alkali used	38.55c.c.	41.90c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

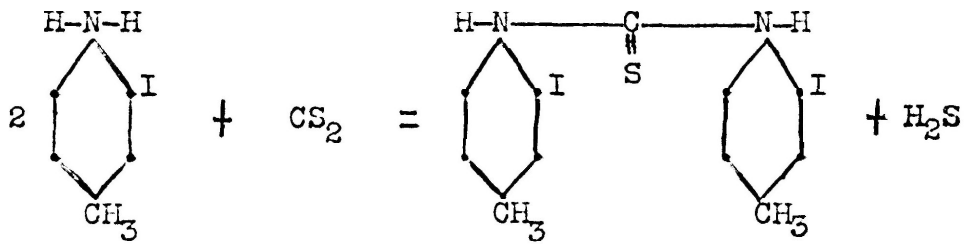
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	Found I	Found II
$\%N_2$	6.76%	6.70%	6.62%

DI(2 IODO-4 METHYL-PHENYL) THIO-UREA.

6 gm. iodo-para-toluidine.
2 gm. carbon disulphide.
0.5 gm. sulphur.

The iodo-para-toluidine, sulphur, and carbon disulphide were mixed in a large test tube, which was then fitted with a reflux condenser and heated on the water bath for about an hour. After standing a couple of days the solution became solid, and the solid was then purified by repeated re-crystallization from boiling alcohol. The colorless crystals melted at 156° C. The compound appeared to be unstable, as it decomposed to a reddish brown oil on exposure to the air for a couple of days. Violet fumes were also given off at the starting of the kjehdahl, which did not occur with any of the other iodine derivatives. The reaction is



The product analused as follows –

	I	II
Weight of sample	0.3557gm.	0.4762gm.
c.c. standard acid used	49.23c.c.	48.92c.c.
c.c. " alkali used	40.84c.c.	38.58c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

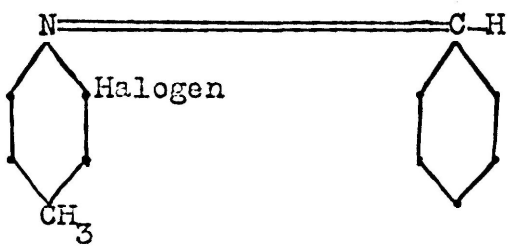
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	5.51%	5.42%		5.46%

2 HALOGEN-4 METHYL-BENZYL-ANILINE.

5 grams of each of the three halogen derivatives of para-toluidine were mixed with the proper amounts of benzaldehyde,placed in large test tubes and heated on an oil bath. They were first heated six hours at 120° C.,then nine hours at 130° C. and finally twelve hours at 140° C. but no solid product could be obtained. Some few crystals were to be seen in the iodo-derivative tube,one or two in the brom-derivative tube,but none what so ever in the chlor-derivative tube. The tubes were then allowed to stand for some four weeks,but the solutions did not solidify.

The product obtained from the solidification of the solutions would doubtless have been

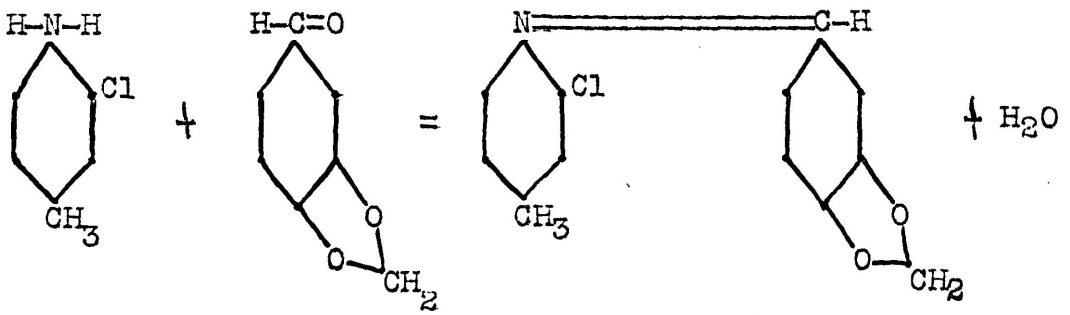


water being eliminated, but as no products were obtained for analysis,no results can be given.

2 CHLOR-4 METHYL-PIPERONAL-ANILINE.

2 gm. chlor-para-toluidine.
2 gm. piperonal.

The above mentioned portions of chlor-para-toluidine and piperonal were mixed in a large test tube, which was then heated on an oil bath at 120° C. for three hours. The solid obtained was then purified by recrystallization from boiling alcohol, and was found to have a melting point of 85° C. The reaction may be represented by



An analysis gave the following results -

	I	II
Weight of sample	1.2509gm.	0.7753gm.
c.c. standard acid used	47.28c.c.	49.34c.c.
c.c. " alkali used	26.23c.c.	35.06c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

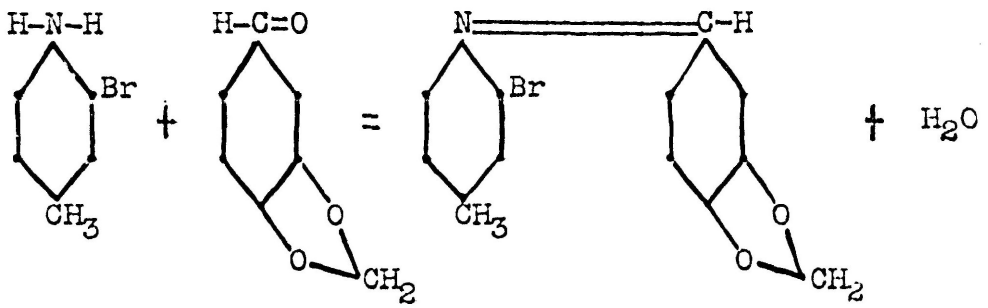
1 c.c. of standard acid equals 0.003226gm. N_2

	Calculated	Found I	Found II
$\%N_2$	5.13%	5.03%	5.08%

2 BROM-4 METHYL-PIPERONAL-ANILINE.

5 gm. brom-para-toluidine.
4.2 gm. piperonal.

The brom-para-toluidine and piperonal were mixed in a large test tube and then heated on an oil bath for ten hours at 120° C. A solid product was obtained which was purified by recrystallization from hot alcohol. The melting point of the crystals was found to be 93° C. The reaction is as follows



The product analysed as follows -

	I	II
Weight of sample	0.9053gm.	0.7687gm.
c.c. standard acid used	49.35c.c.	48.98c.c.
c.c. " alkali used	35.26c.c.	36.53c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

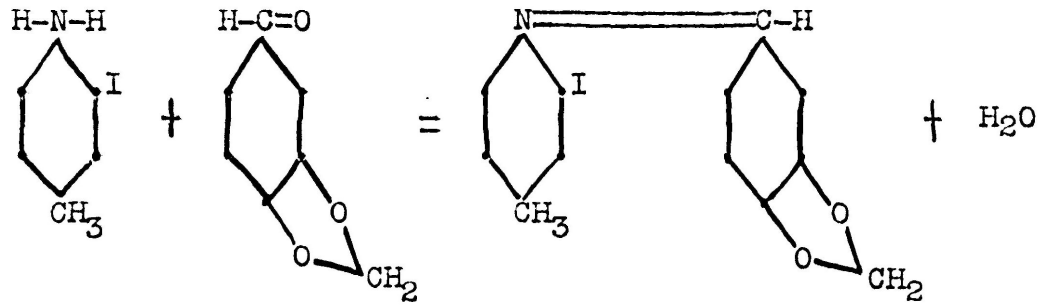
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	Found I	Found II
$\%N_2$	4.40%	4.28%	4.32%

2 IODO-4METHYL-PIPERONAL-ANILINE.

5 gm. iodo-para-toluidine.
3.2 gm. piperonal.

The iodo-para-toluidine and the piperonal were mixed in the above mentioned proportions in a large test tube,which was then heated in a large oil bath for five hours at 120° C. After standing over night the solution solidified,and the solid was then purified by repeated crystallization from boiling alcohol. The colorless crystals melted at 119° C. The reaction is



The product analysed as follows -

		I	II
Weight of sample		0.6866gm.	0.8792gm.
c.c. standard acid used		49.22c.c.	49.64c.c.
c.c.	" alkali used	38.85c.c.	37.19c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

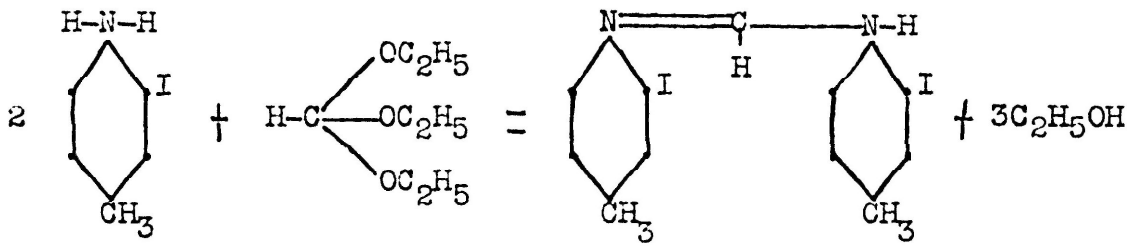
1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	II
$\%N_2$	3.84%	3.74%	3.76%

DI (2 IODO-4 METHYL-PHENYL) FORMANDINE.

10 gm. iodo-para-toluidine.
7 gm. ortho-formic ester.

The above mentioned quantities of iodo-para-toluidine and ortho-formic ester were mixed in a large test tube and heated on a water bath, using a reflux condenser for two hours. No change taking place, the tube was then heated on an oil bath for six hours at 130° C. After standing a couple of days a crystalline product was obtained, which was purified by recrystallization from boiling alcohol. The colorless crystals were found to have a melting point of 107° C. The reaction may be represented by



The product analysed as follows -

	I	II
Weight of sample	0.7236gm.	0.6399gm.
c.c. standard acid used	47.52c.c.	48.94c.c.
c,c. " alkali used	32.48c.c.	35.57c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	I	Found	II
$\%N_2$	5.89%	5.85%		5.68%

The chlor-para-toluidine and brom-para-toluidine were also heated on an oil bath with ortho-formic ester, but refused to give a solid product,even after prolonged heating at higher temperatures,(120° C. to 180° C.).

The rather unexpectedly low melting point of the fairly complex iodo reaction product,caused the author to endeavor to prepare more of the compound for further investigation,all of the first preparation being used in the analyses. However the second product was not obtained as the iodo derivative acted like the other halogen-para-toluidines,and refused to solidify,even after being subjected to longer heating and at higher temperatures. Consequently no further investigation was possible.

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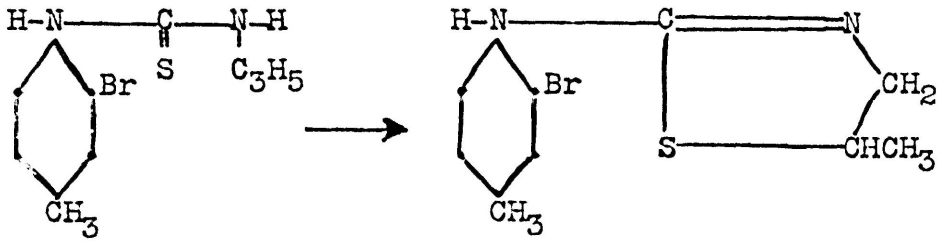
2 (2 BROM-4 METHYL-PHENYL-AMIDO) 5 METHYL-TETRAHYDRO-THIO-AZOLE.

This product was obtained by a rearrangement of 2 brom-4 methyl-phenyl-allyl-thio-urea. 5 grams of the substituted thio urea was placed in a pressure bottle with 40 c.c. of concentrated hydrochloric acid,and heated on a water bath for about ten hours. The solution was then filtered hot,and diluted with water to 500 c.c. After standing twenty four hours,the solution was filtered and the crystals dried. After recrystallization from boiling alcohol,the crystals were found to have a melting point of

153° C. as compared with 85° C.,the melting point of the substituted thio urea. The reaction may be represented by



An analysis of the compound gave the following results -

	I	II
Weight of sample	1.2795gm.	0.8731gm.
c.c. standard acid used	49.59c.c.	49.18c.c.
c.c. " alkali used	10.35c.c.	21.44c.c.

1 c.c. of alkali equals 1.059c.c. of acid.

1 c.c. of standard acid equals 0.003226 gm. N_2

	Calculated	Found I	Found II
$\%N_2$	9.82%	9.74%	9.78%

SUMMARY of RESULTS

Compounds	Melting Points.			Time of reaction.		
	Cl	Br	I	Cl	Br	I
2 halogen-4 methyl-phenyl-allyl-thio-urea	92°	85°	111°	Immed.	10 Min.	1 Hr.
2 halogen-4 methyl-phenyl-phenyl-thio-urea	156°	162°	160°	Immed.	15 Min.	2 Hr.
2 halogen-4 methyl-phenyl-ortho-tolyl-thio-urea	Not made.	127°	Not made.	Not made.	4 Hr.	Not made.
Di (2 halogen-4 methyl-phenyl) thio-urea	134°	145°	156°	12 Hr.	2 days.	2 days.
2 halogen-4 methyl-piperonal-aniline	85°	93°	119°	3 Hr.	10 Hr.	5 Hr.
Di (2 halogen-4 methyl-phenyl) formandine	No reaction.		107°	No reaction.		6 Hr.
2 (2 halogen-4 methyl-phenyl-amido) 5 methyl-tetrahedral-thio-azole	Not made.	153°	Not made.	Not made.	10 Hr.	Not made.

From the above table a comparison of the observed melting points of the various compounds,and of the speed of reaction of any of the three halogen derivatives to form any particular compound,may be made. As far as the work was carried,we may say,in general,

(1)the compound with the smaller molar weight has the greater speed of reaction,i. e.,the chlor derivative

reacts the quickest,and the iodo derivative reacts the slowest;

(2)the greater the molar weight of the compound, the higher the melting point,i. e.,in any analogous series the chlor compound has the lowest melting point,and the iodo compound has the highest melting point.